NGMS Project Plan

Jude George, James D. McCabe and Leslie Schlect[1]

Report RND-91-004, April 1991

National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

ARC 275 (Rev Feb 81)

NGMS Project Plan

Jude George, James D. McCabe and Leslie Schlect[1]

Report RND-91-004, April 1991

RND Branch
NAS Systems Division
NASA Ames Research Center
Mail Stop 258-5
Moffett Field, CA 94035-1000

---

[1] The authors are employed by Computer Sciences Corporation, NASA Contract NAS 2-12961, Moffett Field, CA 94035-1000

Contents

References

[1] Information Processing Systems. Open Systems Interconnection. Management Information Protocol Specification-Part 2: Common Management Information Services Specification. *ISO DP 9595/2.* February 1987.

[2] K. McCloghrie and M. Rose. Structure and Indentification of Management Information for TCP/IP-based internets. *RFC 1065.* Network Information Center, August 1988.

[3] K. McCloghrie and M. Rose. Management Information Base for Network Management of TCP/IP-based internets. *RFC 1066.* Network Information Center, August 1988.

[4] Dr. J.D. Case. The Simple Network Management Protocol (SNMP) for TCP/IP-based Internets. *ACE Press.* 1989.

[5] Katy Kislitzin. Network Management by Scripts. Presented at the *Lisa IV Conference (USENIX)*, October 1990.

[6] Jim D. McCabe. *Development of the Next Generation Management System: Integrated Management of TCP/IP Based Networks.* NAS Systems Division, NASA Ames Research Center, October 1989.

[7] Jim D. McCabe. *A Proposal for the Development of a Network Operations Center for the NAS Facility.* NAS Systems Division, NASA Ames Research Center, August 1990.

1 Introduction

This document is the first part of a series designed to show the development of a network management system by and for the Numerical Aerodynamic Simulation (NAS) Systems Division.

The first section of this document is a requirements specification for the management system. The second section is a brief and general overview of the design of the system and how it will function in its network management role; this will facilitate understanding of the features listed later in the document. The remainder of the document is divided into plans outlining the system releases, hardware acquisition, and software development. The release plan describes the progression of systems that are to be developed and shows the features and goals of each system. The hardware plan describes the initial hardware platforms, additions, and upgrades for subsequent versions. The software development plan describes the planned schedule, budget, and manpower required for development of software components for each system.

2 Requirements Specification

As networks increase in size and complexity, the need to gather and display information about the states of computer systems attached to the networks and the networks themselves becomes increasingly important. NAS has relied on network monitors to perform these functions. Network monitors should, in general, provide for:

1. Continuous monitoring of NAS networks and attached computer systems, for troubleshooting purposes.

2. Gathering of network performance statistics for future planning.

Throughout its history, the NAS Program has had to rely on several proprietary, mutually exclusive, network management systems to monitor local- and wide-area networks. This reliance on vendor-supplied systems has been problematic; all of the network management systems at NAS have had difficulties in that they:

- Monitor only a small fraction (1-10 percent) of the NAS computer systems. This is due in part to the proprietary nature of the management systems; they typically monitor only those computer systems directly attached to the vendor's network. Each network architecture (Ethernet, LattisNet, HYPERchannel, UltraNet, FDDI, Bridged Ethernet WAN) requries a proprietary monitor.

- Are designed such that all monitoring software is located on a single computer platform. All monitoring functions, i.e., sending queries, listening for responses, building a list of computer systems and their states, displaying state information, are located on one computer platform. Some example platforms are DEC MicroVAX for Network System's HYPERchannel monitor, Wyse 386 PC for Ultra Network Technologies' UltraNet monitor, and DEC VAXStation for Vitalink's 802 WANManager. There are three problems with such a design:

    1. All queries must originate from the monitor, and all responses must terminate at the monitor. As a result, queries and responses may have to traverse networks where neither the monitor nor the monitored computer system are located. This "transient" traffic is an overhead burden to all networks in the path of the network monitor.

    2. Since all components of the monitor are co-resident in the one computer platform, the failure of any single component can adversely affect the entire monitoring system.

    3. The network where the monitor is located, as well as the monitor itself, are bottlenecks for monitor traffic. If the amount of monitor

traffic is greater than the monitor's I/O capacity, the monitor will fail.

- Network monitors do not provide facilities for control of the network and attached computer systems. Control is the modification of parameters on the network and/or computer systems to produce a change in the behavior of that system.

An analysis of the problems associated with current network monitors has led to the development of a list of requirements for a network monitor for NAS. These requirements form the basis for the design of a network management system, where management is defined as the sum of monitor and control functions. The requirements are:

1. An architecture where:
   - The monitoring software is distributed on several computer platforms across multiple networks.
   - Queries and responses are localized to the network of the monitored computer system, not of the monitor.
   - Status of networks/computer systems and network performance statistics form a centralized resource that is offered as a service to any computer system that has the proper software to display such information.
   - The loss of any single component of the management system will not result in the loss of the entire management system.
2. The use of American National Standards Institute (ANSI) and/or Internet standards:
   - The *UNIX* operating system for computer platforms.
   - *X-Windows* for graphical displays.
   - Software written in the *C* programming language.
   - *Internet Protocol* (IP) for network communications.
   - *Simple Network Management Protocol* (SNMP) [Case89] for access to network/computer systems that have SNMP agents.
3. A graphical user interface that:
   - Shows the status of all monitored network/computer systems in a single display.
   - Shows in detail selected network/computer systems. Allows the user to determine which networks and how much of each network to display in detail.

- Shows network/computer system-dependent performance statistics.
- Provides direct access to network/computer systems via *telnet*.

A survey of network monitor and management systems was done from 1989 to 1990. The survey consisted of evaluations of each of the systems through either a beta/field test, in-house evaluation, or a demonstration at the vendor's site. The results are shown in Appendix A.

None of the systems evaluated during the survey were able to meet the requirements listed above.

For this reason, and the desire to use a non-proprietary network management system at NAS, in-house development of a network management system has been started.

3 Design Overview

The *Next Generation Management System* (NGMS) is the NAS development project that addresses the design issues associated with the requirements listed in the Requirements Specification.

Design of the NGMS is based on flexibility in meeting the requirements listed above. The system is designed so that the management software is modularized into software components; this is done so that components can be distributed in many different computer platforms across all current network architectures. In doing so, we build robustness into the system; software modules that are distributed across networks can assume responsibility for each other in the case of failure. How many and where modules are distributed is left to the discretion of the implementor. This flexibility allows the implementor to chose the best configuration based on cost, size and design of network, number of network operators, etc. The minimum implementation is one that is architecturally similar to current proprietary systems where all of the management software is located on the same computer platform.

The NGMS software modules have specialized functions. This allows the lowest level network functions (sending queries and listening for responses), which require 50-80 percent of the total network management bandwidth in steady-state operation, to be located in modules that are distributed to the networks being queried. The result is that the network traffic caused by queries and responses does not converge on a single network but instead is localized to the networks where it was originated.

In a similar fashion, the NGMS displays use a software module that can be located wherever the user has the required hardware. This allows flexibility in both the number of users viewing the network and where they are located.

Another specialized function is the development and maintenance of network/computer system status and performance. The software module that performs this function gets its information from the distributed low level modules and builds an information base that it offers to other modules (such as those that display information to the user) as a resource. An extension to this function is the long term storage of network/computer system status and performance information via archival in a database.

Finally, network management involves the control of network/computer system parameters in order to achieve network stability and performance. One function of the NGMS is to provide assistance in the control of network/computer system parameters through the use of artificial intelligence.

The NGMS consists of three major components:

1. Software for hierarchical and distributed network management. This software forms the *Hierarchical Network Management System* (HNMS).

2. A protocol for communcications between software modules within the

HNMS. This protocol is the *Hierarchical Network Management Protocol* (HNMP).

3. Hardware platforms for monitoring and display.

These components are described in the following sections.

3.1 Hierarchical Network Management System

The *Hierarchical Network Management System* consists of software modules that perform five network management functions; collection, display, archival, intelligent processing of network management data, and network topology management. The software modules, whose designs are based on these five functions, are called Functional Modules.

Functional Modules (FMs) are the basic software components of the HNMS. Along with the *Hierarchical Network Management Protocol* (HNMP), FMs form the software structure of the NGMS. FMs are identified by their major functions:

1. Input/Output (I/O) module.
2. Topology Server (TS) module.
3. User Interface (UI) module.
4. Database (DB) module.
5. Rules-Based Intelligent Processor (RBIP) module.

A brief description of each module follows.

3.1.1 I/O Module

The I/O module functions as a low level gatherer of network/computer system data. It is designed to accumulate status and performance data on systems within its management domain. Management domains are determined by the Topology Server (TS) module and passed down to I/O modules, and consist of lists of network/computer systems to manage. Such a list may be a simple as an Internet Protocol (IP) network number like 129.99 (which would mean monitor all systems within the 129.99 network) or as complicated as an explicit list of IP numbers for subnets and computer systems.

Once configured with a management domain, the I/O module develops and maintains the status and performance data for all reachable systems within its domain. This data is checked against previous system data for changes in the network, and all changes are reported to the TS.

The number of I/O modules used by the NGMS is dependent on the implementor, and has no known upper bound, but must be at least one.

TS and I/O modules keep in touch on a regular basis, either to report changes in the network or to maintain reachability.

In the event that an I/O module cannot reach the TS, the management domain of that I/O module is reassigned by the TS to another I/O module. Thus, I/O modules act in backup to each other, providing redundancy for the HNMS.

3.1.2 Topology Server Module

The Topology Server (TS) module keeps the latest status and performance data for all of the network/computer systems within the HNMS management domain. It gets this data from the I/O modules that it communicates with, and receives updates from the I/O modules on an as-needed basis. TS modules act as a central repository for this data and provide access to it for all User Interface (UI) modules.

In addition, TS modules manage connections between themselves and all other modules. For I/O modules, this includes both initial assignment of and subsequent modifications to the management domains.

Only one TS module may be in active operation at a time. Other TS modules can act in a passive, non-participatory mode, ready to assume responsibilities should the active TS module fail.

3.1.3 User Interface Module

The function of the User Interface (UI) module is to provide its users (development, management, and operations personnel) with a graphical representation of network/computer system status and performance data.

In performing its function, the UI module enables the HNMS to display changes in network/computer systems within seconds of their occurances and provide users with data about the performance of network/computer systems, for troubleshooting or planning purposes.

Multiple UI modules can exist on the network simultaneously and will acquire data from the TS module.

UI modules show, by default, the entire management domain of the HNMS, but can be configured by the user to display subsets of the network such as individual or groups of subnets or computer systems.

3.1.4 Database Module

The Database (DB) module acts as a long term repository for data accumulated by the HNMS. This module stores performance data, defined by the user, via its connection to the TS module. This provides the user with the ability to do historical analyses to aid in troubleshooting or in establishing trends.

3.1.5 Rules-Based Intelligent Processor Module

The functions of the Rules-Based Intelligent Processor (RBIP) module are to aid the user in gathering and processing network/computer system data, and possibly acting on the results. These functions will be more clearly understood when the prototype HNMS is being used.

3.2 Hierarchical Network Management Protocol

The *Hierarchical Network Management Protocol* (HNMP) is used to provide communications between HNMS FMs, but may also be extended to accomodate other functional paradigms for distributed network management. It is designed to provide communications between FMs whether they are spread across several networks, concentrated on one network, or contained within a single host.

HNMP provides for extension of network management from the current model of containment within a single host or network architecture to distributed management across multiple networks and architectures by allowing:

1. Distribution of FMs to strategic points in the network(s).
2. Allocation of as many FMs as are needed.

HNMP is designed to facilitate three interactions between FMs:

1. Initiation of control functions in the FMs, through the setting of FM parameters.
2. Establishing responsibilities for the collection, archiving, and display of management data, as well as the determination of management domains.
3. Passing of network management data between FMs, using a query-response method as well as a subscription method.

3.3 Software Architecture

Figure 1 shows the relationships of the HNMS Functional Modules.

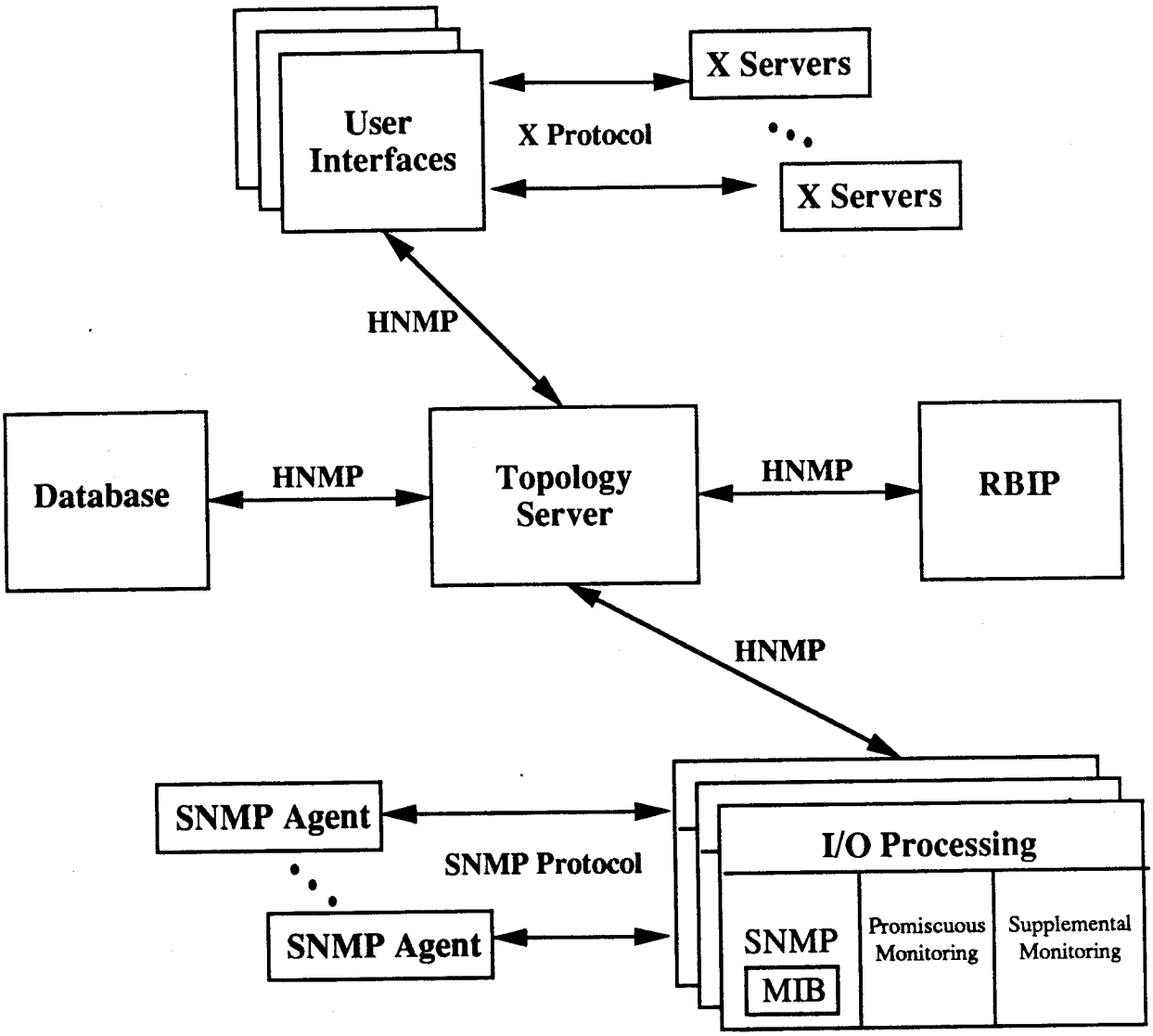


Fig. 1 Software Architecture of the HNMS.

4 Release Plan

The following sections describe the goals and features of each release of the *Next Generation Management System* (NGMS) and give an outline of the components. NGMS consists of three major components:

1. Hardware platforms for monitoring and display.
2. Software for hierarchical and distributed network management. This software is the *Hierarchical Network Management System* (HNMS).
3. A protocol for communications between software modules within HNMS. This protocol is referred to as the *Hierarchical Network Management Protocol* (HNMP).

There are three planned releases of NGMS; Prototype, Version 1.0 and Version 2.0. Each release is based on two goals; achieving the level of functionality which is set for that release and proving the new concepts that are introduced.

4.1 Prototype

This is the initial version of NGMS, and is primarily intended as a proof of concept. In order to achieve this, the main goal of the prototype is to show that a hierarchical network management system is feasible. This goal will be accomplished in two stages: first, through the deployment and successful operation of NGMS, it will be shown that the hierarchical architecture is viable; second, system performance will be tested to show the effectiveness of hierarchical management.

A second goal of the prototype is to show the capability of a single management architecture to monitor systems across all network technologies.

The prototype has the following features:

- The prototype configuration consists of User Interface (UI), Topology Server (TS) and Input/Output (I/O) modules resident on an SGI IRIS 4D/320 VGX workstation, a UI on an IRIS 4D/70G, an I/O module on a Sun SPARCstation, and an I/O module on a Sun 3/260.
- The monitoring, control, and display functions are performed by software modules located on separate hardware platforms. Information about network status is received by Open Systems Interconnect (OSI) layer 1-3 monitoring software and is condensed into updates that are used to build a topology map by the Topology Server (TS). User Interface modules subscribe to a subset of this information for display purposes. This results in a hierarchy of information flow between software modules.

- All NAS network elements that have active *Simple Network Management Protocol* (SNMP)-based agent software or that can be accessed via an SNMP proxy agent will be monitored. This includes elements of the NAS wide-area network *AEROnet*.

- Software modules will use the *Hierarchical Network Management Protocol* (HNMP) for communications. A description of this protocol is given in the Design Overview section. HNMP prototype development will be done in Franz Allegro Common Lisp.

- HNMS UIs will have two windows to display the status of network elements on the network: one will show all monitored network elements at-a-glance, independent of network technology, and the other will show a subset of those network elements in detail. In addition, logical sections of the network, such as subnets, hosts, or interfaces, can be isolated for closer inspection.

- Displays of network topology will automatically update to add, delete, or change icons representing topology information. The status of each network element that is monitored by I/O modules will be represented by colors following an 6-color, 3-state scheme.

- Network statistics (see below) are logged into standard UNIX files.

- I/O modules will incorporate software to enable promiscuous monitoring of ethernet networks. The information gathered by this technique will be used to supplement SNMP-based data.

- The following statistics will be gathered by NGMS and will be made available by display on an UI and/or through report generation (time periods are user-definable):

    1. Frames and/or packets per time period per interface.
    2. Octets and/or bits per time period per interface.
    3. Errors per time period per interface. The number and types of errors are a function of the type of network element and vendor and therefore will be determined at the time such elements are procured.

4.2 System 1.0

This version is intended as a production quality system based on a stable software platform. Changes to the prototype system based on input from the operations staff will be incorporated into this release.

The primary goal of this release is to show the feasibility of a distributed network management architecture. This will be accomplished by testing the

fault tolerance of the distributed system through simulating the loss of software modules.

The Hierarchical Network Management Protocol will be rewritten in C for use in this and subsequent versions.

This release has the following features:

- The distributed management architecture will be implemented. This architecture is based on having multiple I/O modules dispersed across all network technologies at NAS and UI modules located at network operator sites. Thus, one I/O module will be developed for each of the UltraNet, HYPERchannel, and FDDI networks. Three additonal ethernet I/O modules will also be developed for use on NAS ethernet subnets. Five I/O modules will also be used at AEROnet regional centers. These centers are:

  1. Langley Research Center (LaRC)
  2. Lewis Research Center (LeRC)
  3. Marshall Space Flight Center (MSFC)
  4. Johnson Space Center (JSC)
  5. Jet Propulsion Lab (JPL)

- A DataBase module (DB) will be added to HNMS for the logging of network performance, topology, administration and error information. The DB module will provide for the generation of reports about such information.

- Support for SNMP traps will be added. The User Interface will report the following network events:

  1. An entity sending the trap is reinitializing itself such that the agent's configuration or the protocol entity implementation may be altered. (*coldStart* trap). An agent is the implementation of SNMP software resident in the managed system.
  2. An entity sending the trap is reinitializing itself such that no alteration to either the agent's configuration or the entity implementation will occur. (*warmStart* trap).
  3. A failure has been recognized in one of the communications links represented in the agent's configuration. (*linkDown* trap).
  4. Service has returned to one of the communications links represented in the agent's configuration. (*linkUp* trap).
  5. The sending entity has received a protocol message that is not properly authenticated. (*authenticationFailure* trap).

6. The Exterior Gateway Protocol (EGP) neighbor for whom the sending entity was an EGP peer has been marked down and the peer relationship no longer exists. (*egpNeighborLoss* trap).
7. The sending entity recognizes some enterprise-specific event, which is defined by the enterprise-specific (read vendor-specific) Management Information Base (MIB) (*enterpriseSpecific* trap).

These events will be logged by the database module.

- Displays of network topology will autoconfigure upon startup.
- Network elements displayed on UIs can be sorted by:
  1. Time of last recognition by an I/O module.
  2. Name of network element.
  3. Type of network element.
- Dual color monitors will be incorporated on the primary UI workstation for separate displays of the local- and wide-area networks. Additionally, displays will be converted to using only the X-Windows protocol.
- The User Interface will have the capability to graphically display, via bar or line graphs, the following performance statistics:
  1. Frames/Packets per time period per network interface.
  2. Octets/bits per time period per network interface.
  3. Vendor-specific errors per time period per network interface.
  4. Bandwidth utilization per time period per communications link (as a percentage of total available bandwidth). For data paths comprised of multiple parallel links, the total available bandwidth variable will reflect the sum of bandwidths from all links, thus providing a measure of link availability. This statistic may be broken down by:
     (a) Total traffic
     (b) Network protocol
     (c) IP network or subnet number
     (d) Type of application
- A display will be added to graphically show the routing topology of NAS networks. This information will be obtained from the routing tables of local- and wide-area network routers.
- An on-line help facility will be added.

- A search function will be added to allow a user to locate a network element, by either IP address or hostname, and display that element highlighted and in detail.
- For each of the statistics monitored by I/O modules, a threshold parameter may be set such that the user will be notified if that variable exceeds the threshold.
- The following additional statistics will be gathered by I/O modules and will be made available either by display on monitors and/or through report generation:
    1. Average packet size per network.
    2. Availability of network routers. This will be based on the ratio (responses to SNMP polls)/(total number of SNMP polls).
    3. Data link utilization by:
        (a) Internet Protocol (IP) network or subnet number
        (b) Network (ISO layer 3) protocol
        (c) Type of application
- An algorithm for determining the availability of NAS networks will be incorporated in the HNMS. This algorithm will provide an availability metric comparable to that obtainable via the NAS utility *pingit* [Kislitzin90].

4.3 System 2.0

This version of NGMS has two primary goals. First, this system is intended to be the focal point for a *Network Operations Center*, or NOC [McCabe90]. While the development of an NOC for NAS is ancillary to the NGMS effort, a primary goal of this system is to support an operational NOC. Second, NGMS will provide a platform for research in expert systems applications in network management.

This release has the following features:

- A Rules-Based Intelligent Processor (RBIP) module will be added. This module will use artificial intelligence technology to process incoming network management data and, based on the results of that processing, query for more problem-specific data or take appropriate action to solve the problem.
- NGMS will incorporate dual projection systems for use with the dual monitor IRIS 4D/320VGX. These projection systems will enable the displays for local- and wide-area networks to enlarged for viewing in the NOC.

- Proxy-SNMP support for physical layer (ISO layer 1) monitoring of NAS ethernets will be available. The following objects will be monitored:

    1. Bandwidth utilization of the physical media.
    2. IEEE characteristics of interfaces to the physical media. Which characteristics will be monitored have not been determined at this time.

- Out-of-band access to I/O software modules will be added for redundant access to HNMS data at times of network partitioning. This access will be provided though the use of modems.

- The User Interface will provide a graphics editor so the user can customize the network display by creating, deleting, or modifying icons.

5 Documentation Plan

There are three documents associated with the development of the Next Generation Management System. They are the *NGMS Project Plan* (this document), the *NGMS External Reference Specification*, and the *HNMS Internal Design Specification*. These documents describe the requirements driving the development effort, NGMS architecture, and how this architecture is to be implemented.

5.1 The NGMS Project Plan

The purpose of the *NGMS Project Plan* (this document) is to provide an overview of what features each release of NGMS will provide, the goals to be accomplished, and the major tasks required to achieve these goals.

5.2 The NGMS External Reference Specification

The *NGMS External Reference Specification* document describes in detail NGMS architecture and how the features listed in the *NGMS Project Plan* are to be implemented. This document is intended as a design roadmap that will closely parallel and evolve with system development.

5.3 The HNMS Internal Design Specification

This document is a description of HNMS software by the implementors of this project and serves three purposes:

1. Acts as the source for control of code changes as development progresses
2. Provides a HNMS system maintenance guide
3. Provides a detailed description of the algorithms and data structures used in HNMS

6 Equipment Acquisition Plan

The following sections list the hardware that is required to implement each version of NGMS. Some of the hardware listed here may already be available and as such will not have to be purchased.

6.1 Prototype

Prototype development will be done on an SGI IRIS 4D/320 VGX graphics workstation, an IRIS 4D/70G, a Sun SPARCstation, and a Sun 3/260. Systems will initially have interfaces to ethernet.

6.2 System 1.0

For this release nine hardware platforms will be required. These systems will be at least Sun SPARCstations and may include SGI IRIS systems. Five systems will be needed for AERONet, one for each AERONet area center, and four additional systems for NAS subnets.

An additional color monitor will be required for the SGI IRIS 4D/320 VGX for this release.

6.3 System 2.0

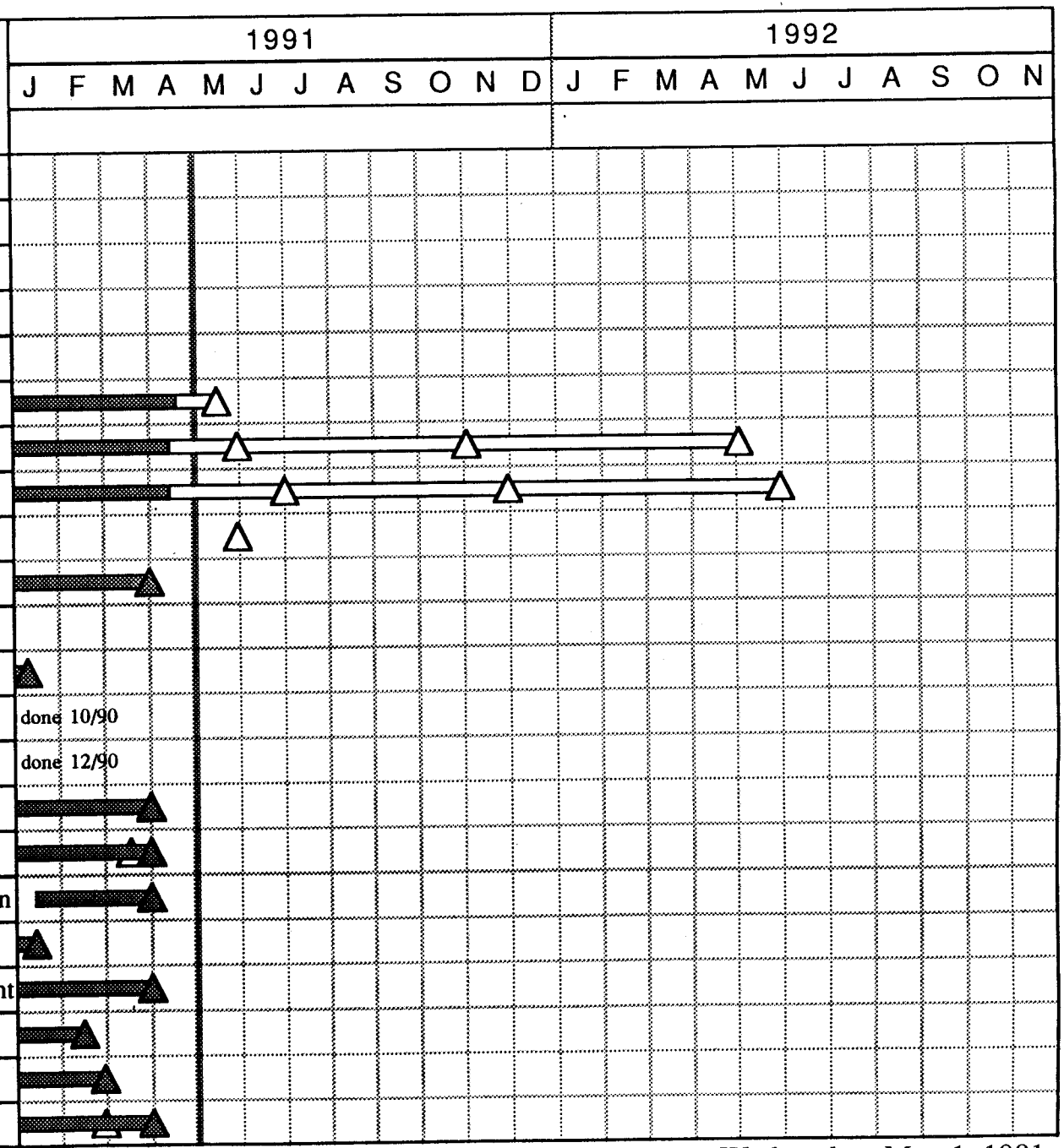
One additional platform is necessary for this release, for the implementation of RBIP software. The type of system appropriate for RBIP software has not been determined at this time.

Two color projection systems will be used in conjunction with the dual monitor version of the SGI IRIS 4D/320 VGX.

7 Schedule

This section lists the initial, current, and final dates of completion of milestones and delivery of final product for each NGMS release.

NGMS Development Schedule



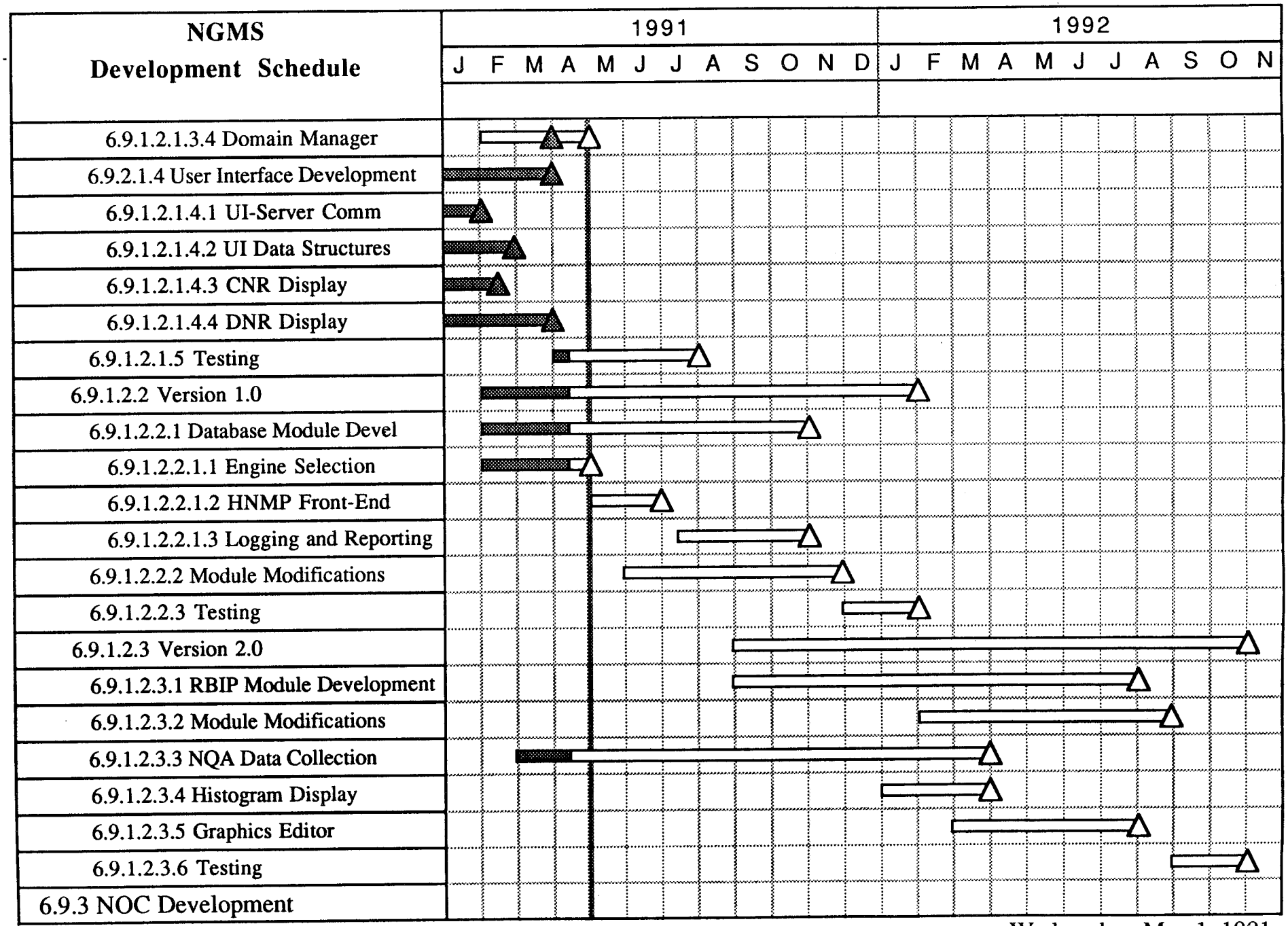
Numbers map to Contract Task Order Items

6.9 Performance Monitoring

- 6.9.1 NGMS Design and Development
  - 6.9.1.1 NGMS Design
    - 6.9.1.1.1 Project Plan
    - 6.9.1.1.2 Engineering Requirement Spec.
    - 6.9.1.1.3 Internal Design Specification
    - 6.9.1.1.4 CDR
  - 6.9.1.2 NGMS Development
    - 6.9.1.2.1 Prototype
      - 6.9.1.2.1.1 HNMP Development
        - 6.9.1.2.1.1.1 SNMP Tool Kit
        - 6.9.1.2.1.1.2 LISP-C Interaction
      - 6.9.1.2.1.2 I/O Module Development
        - 6.9.1.2.1.2.1 SNMP Data Collection
        - 6.9.1.2.1.2.2 Ethernet Data Collection
        - 6.9.1.2.1.2.3 I/O-Server Comm
      - 6.9.1.2.1.3 Server Module Development
        - 6.9.1.2.1.3.1 HNMP Front-End
        - 6.9.1.2.1.3.2 Topology Manager
        - 6.9.1.2.1.3.3 Subscription Manager

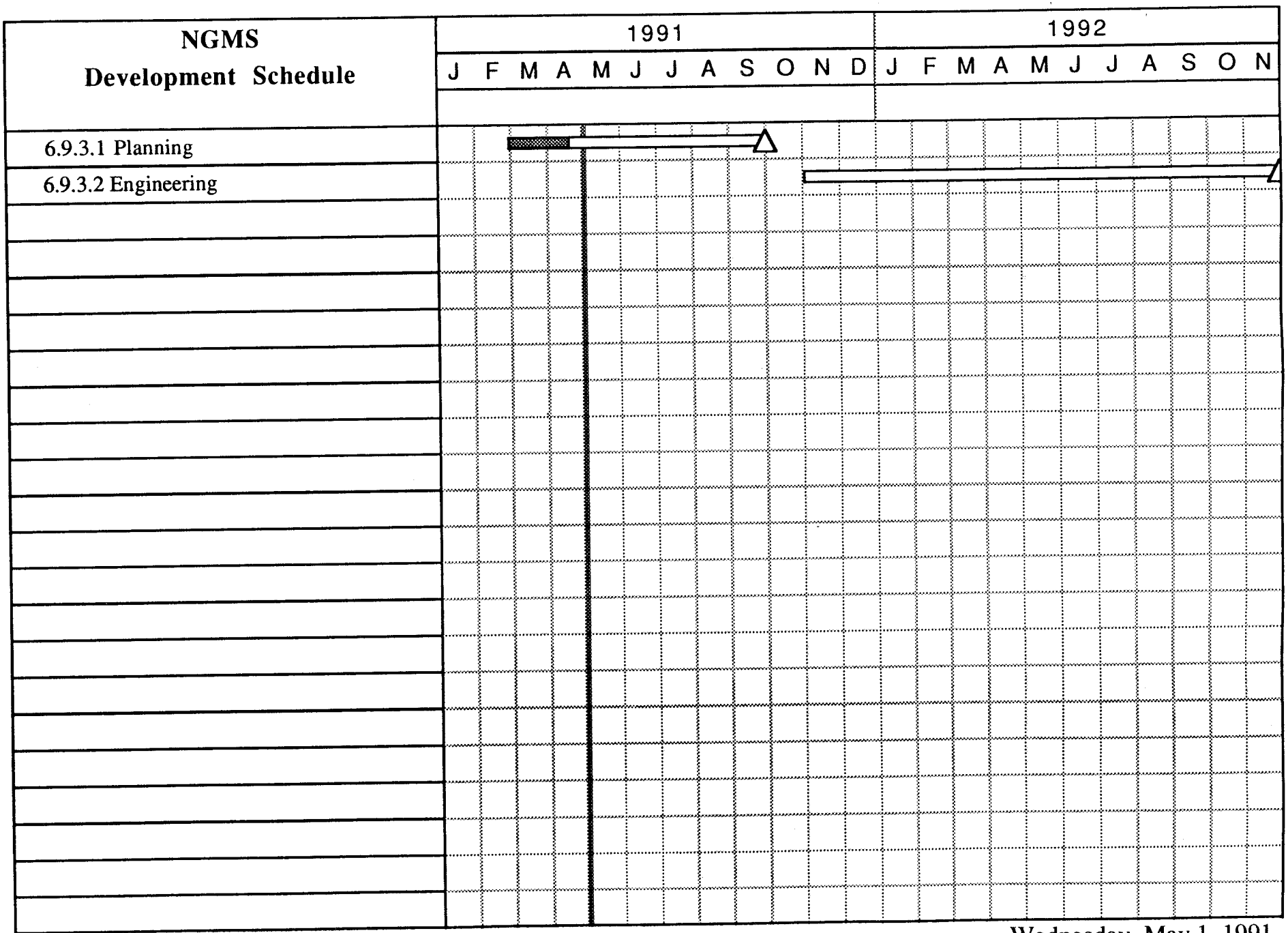
Jim D. McCabe

Wednesday, May 1, 1991



Jim D. McCabe

Wednesday, May 1, 1991



Jim D. McCabe

Wednesday, May 1, 1991

8 Budget

This section shows the budget for the NAS Long Haul Communications Subsystem as it pertains to the NGMS effort.

9 Manpower

This section shows the manpower loading for the NAS Long Haul Communications Subsystem as it pertains to the NGMS effort.

NAS SYSTEMS DIVISION — REQUIREMENTS BUDGET FORECAST $K

BRANCH: RND
SUBSYSTEM: LHCS
ACCOMPLISHMENT: J. McCabe
DATE: 4/91

REQUIREMENT	FY91	FY92	FY93	FY94	FY95	FY96	FY97	Comments
Performance Monitoring								
Prototype								
Prototype Platform	35							
Version 1.0								
Version 1.0 Platform		100						
I/O Module Platforms		50						
Color Monitor	15							
Database	30							
Version 2.0								
RBIP Platform		10						
NQA Integration		35						
Projection Systems			100					
NOC Engineering		25	95					
Upgrades				50	150	50	150	
Total	80	220	195	50	150	50	150	

10 Appendix A

This section displays the results of a survey of network management systems that was done from 1989 - 1990.

The survey consisted of evaluations of each of the systems through either a beta/field test, in-house evaluation, or a demonstration at the vendor's site.

NAS SYSTEMS DIVISION

MANPOWER LOADING

BRANCH RND

SUBSYSTEM LHCS

ACCOMPLISHMENT J. McCabe

DATE 4/91

	FY91									
	Q1	Q2	Q3	Q4	92	93	94	95	96	97
Systems Programmers										
User Interface Module	0.5	0.5	0.5	0.5	0.5	0.25	0	0	0	0
TS, I/O Modules	0.5	0.5	0.25	0.25	0.25	0	0	0	0	0
HNMP Development	0.25	0.25	0	0	0	0	0	0	0	0
Database Module	0	0.25	0.25	0.25	0	0	0	0	0	0
RBIP Module	0	0	0.25	0.5	0.5	0.25	0	0	0	0
Design/Documentation	0.25	0.25	0.25	0.25	0.25	0	0	0	0	0
NOC Development	0	0	0	0	0.25	0	0	0	0	0
Total	**1.5**	**1.75**	**1.5**	**1.75**	**1.75**	**0.5**	**0**	**0**	**0**	**0**

Vendor	Can monitor entire nework	hierarchical displays	selective displays	Provides fault tolerance	Scales well	Accurate topological data	Good I/O capabilities	Is portable	Non-proprietary system	Has a physical layer monitor
ACC	√									
cisco	√				√					
CSC	√		√							
HP	√		√							
NSC			√			√				
NYNEX		√	√	√		√				
NYSERnet	√		√		√	√		√		
Proteon	√		√			√				
SGI			√	√	√	√	√			
SNMP Res	√		√		√	√		√		
Sun	√	√	√		√					
Synoptics		√				√				
Ultra			√			√				
Vitalink			√			√				

Vendor Evaluations